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II. **Solution by G. B. M. ZERR, A. M., Ph. D., Texarkana, Arkansas, and the PROPOSER.**

Let t=number of seconds, n=number of miles per hour.

$\therefore$ $5280n/3600=22n/15$ feet per second=speed of train. Also in t seconds train goes $30n$ feet.

$\therefore$ $30n/t$=number of feet in one second.

$\therefore$ $30n/t=22n/15$. $\therefore$ $t=20\frac{5}{11}$ seconds.

78. **Proposed by NELSON S. RORAY, South Jersey Institute, Bridgeton, New Jersey.**

Solve by pure arithmetic, no algebraic symbols: A Texan farmer owns 5169 cattle; there are 3 times as many horses as cows, plus 569, and 4 times as many cows as sheep, minus 126; how many has he of each? [From *Brooks' Higher Arithmetic.*]

Solution by G. B. M. ZERR, A. M., Ph. D., Texarkana, Arkansas, and J. C. CORBIN, Principal of Schools, Pine Bluff, Arkansas.

$5169+126-569=4726$=number of cattle when there are 4 times as many cows as sheep and 3 times as many horses as cows.

Every time he takes 1 sheep, he takes 4 cows and 12 horses, or 17 in all.

$\therefore$ he has as many lots of 1 sheep, 4 cows, 12 horses, as 17 is contained in 4726. $\therefore$ $4726\div17=278$.

$\therefore$ 278×1=number of sheep= 278

$278\times4-126$=number of cows= 986

$278\times12+569$=number of horses=3905

Total=5169

This problem was solved with a different view of its enunciation by Frederic R. Honey, and O. S. Westcott, A. M., Sc. D., Principal North Division High School, Chicago, Illinois.

[NOTE. P. S. Berg and H. C. Wilkes should each have received credit in the last number for solving problems 75 and 76. EDITOR.]

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ALGEBRA.

Conducted by J. M, COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

70. **Proposed by J. A. CALDERHEAD, A. B., Professor of Mathematics in Curry University, Pittsburg, Pennsylvania.**

Given $\sqrt[3]{(a+x)}+\sqrt[3]{(a-x)}=\sqrt[3]{c}$ to find x.

I. **Solution by J. MARCAS BOORMAN, Consultative Mechanician, Counselor at Law, Inventor, Etc., Hewlett, Long Island, New York; EDWARD R. ROBBINS, Master in Mathematics and Physics in Lawrenceville School, Lawrenceville, New Jersey; E. L. SHERWOOD, A. M., Principal of City Schools, West Point, Mississippi; O. W. ANTHONY, M. Sc., Columbian University, Washington, D. C.; A. H. HOLMES, Brunswick, Maine; and J. SCHEFFER, A. M., Hagerstown, Maryland.**

Cubing, transposing, etc.,

$$(a^2-x^2)^{\frac{1}{3}}\left[(a+x)^{\frac{1}{3}}+(a-x)^{\frac{1}{3}}\right]=(c-2a)/3, \text{ or } (a^2-x^2)^{\frac{1}{3}}\left[c^{\frac{1}{3}}\right]=(c-2a)/3.$$

$$\therefore\ x=\pm\sqrt{\left(a^2-\frac{(c-2a)^3}{27c}\right)}.\quad \text{If } c=2a,\ x=a.$$

II. Solution by J. H. DRUMMOMD, LL. D., Portland, Maine; A. H. BELL, Hillsboro, Illinois; and CHAS. C. CROSS, Laytonsville, Maryland.

Transposing $\sqrt[3]{(a-x)}$, cubing and reducing, we have,

$$(a-x)^{\frac{1}{3}}-c^{\frac{1}{3}}(a-x)^{\frac{1}{3}}=(2a-c)/3c^{\frac{1}{3}}\,.$$

Completing the square, we find,

$$(a-x)^{\frac{1}{3}}=\tfrac{1}{2}\left[\ c^{\frac{1}{3}}\pm\sqrt{\left(\frac{8a-c}{3c^{\frac{1}{3}}}\right)}\right].$$

Hence $x=a-\frac{1}{8}\left[\ c^{\frac{1}{3}}\pm\sqrt{\left(\frac{8a-c}{3c^{\frac{1}{3}}}\right)}\right]^3$; or transposing $\sqrt[3]{(a+x)}$, and proceeding as before,

$$x=\tfrac{1}{8}\left[\ c^{\frac{1}{3}}\pm\sqrt{\left(\frac{8a-c}{3c^{\frac{1}{3}}}\right)}\right]^3-a.$$

Messrs. Bell and Cross let $y=\sqrt[3]{(a+x)}$, substitute, and then solve as above.

III. Solution by H. C. WHITAKER, M. Sc., Ph. D., Professor of Mathematics in the Manual Training School, Philadelphia, Pennsylvania.

For convenience in writing, denote $\sqrt[3]{c}$ by b, $\sqrt[3]{(a+x)}$ by y and $\sqrt[3]{(a-x)}$ by z. Of the following equations, (1) is given and the others are assumed. (Take $\alpha^3=1$).

$y+z-b=0$............ (1).

$\alpha y+z-b=A$ ....(2).

$\alpha^2y+z-b=B$ ....(3).

$y+\alpha z-b=C$ .... (4).

$\alpha y+\alpha z-b=D$ ....(5).

$\alpha^2y+\alpha z-b=E$ ....(6).

$y+\alpha^2z-b=F$ ....(7).

$\alpha y+\alpha^2z-b=G$ ....(8).

$\alpha^2y+\alpha^2z-b=H$ ....(9).

We have, by multiplying these three at a time,

$$[y^3+(z-b)^3][y^3+(\alpha z-b)^3][y^3+(\alpha^2z-b)^3]=0.$$

Or, completing the multiplications,

$$(y^3+z^3-b^3)^3+27b^3y^3z^3=0.$$

Restoring the original values of y, z, and b, we get,

$$27c(x^2-a^2)=(2a-c)^3.$$

Hence $x=\sqrt{\left(\frac{(2a-c)^3+27a^2c}{27c}\right)}$.

This may be the root of the given equation or the root of any of the assumed equations, depending on the various values of a and c.

[This example is found in Bonnycastle's Algebra (1845), page 97.]
Also solved by *P. S. BERG*, *H. C. WILKES*, and *G. B. M. ZERR*.

71. Proposed by F. P. MATZ, D. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pennsylvania.

When $x=0$, find the limit of the expression

$$u=\left(\frac{m+x}{m-x}\right)^{\frac{1}{x}}+\left(\frac{m-x}{m+x}\right)^{\frac{1}{x}}.$$

I. Solution by O. W. ANTHONY, M. Sc., Columbian University, Washington, D. C., and G. B. M. ZERR, A. M., Ph. D., Texarkana, Arkansas.

Let $u=u_1+u_2$. $\therefore$ $u_1=\left(\frac{m+x}{m-x}\right)^{\frac{1}{x}}$,

$$\log u_1=(1/x)\{\log(m+x)-\log(m-x)\}$$

$$=(1/x)\{[\log m+(x/m)-(x^2/2m^2)+(x^3/3m^3)-\ldots\ldots]-$$
$$[\log m-(x/m)-(x^2/2m^2)-(x^3/3m^3)-\ldots\ldots]\}$$

$$=\frac{2}{x}\left(\frac{x}{m}+\frac{x^3}{3m^3}+\frac{x^5}{5m^5}+\ldots\ldots\right)=2\left(\frac{1}{m}+\frac{x^2}{3m^2}+\frac{x^4}{5m^5}+\ldots\ldots\right)$$

$=2/m$, when $x=0$. $\log u_2=-\log u_1=-2/m$, when $x=0$.

$\therefore$ $u_1=e^{2/m}$, $u_2=e^{-2/m}$. $\therefore$ $u=e^{2/m}+e^{-2/m}$ when $x=0$.

II. Solution by H. C. WHITAKER, M. Sc., Ph. D., Professor of Mathematics in Philadelphia Manual Training School, Philadelphia, Pennsylvania.

Since $(1+x)^{1/x}=e$ when $x=0$, we have

$$\left(\frac{m+x}{m-x}\right)^{\frac{1}{x}}=\left[\left(1+\frac{2x}{m-x}\right)^{\frac{m-x}{2x}}\right]^{\frac{2}{m-x}}=e^{2/m}\text{ when }x=0.$$